A PRELIMINARY REPORT ON WATER QUALITY CHARACTERISTICS OF KEMPENFELT BAY AND ADJACENT LAKE SIMCOE

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Ministry of the Environment

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The Honourable
William G. Newman,
Minister

Everett Biggs,
Deputy Minister

A PRELIMINARY REPORT

ON

WATER QUALITY CHARACTERISTICS

OF

KEMPENFELT BAY AND ADJACENT LAKE SIMCOE

by

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and

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SUMMARY AND CONCLUSIONS

A preliminary assessment of water quality conditions in Kempenfelt Bay and adjacent Lake Simcoe indicates that localized enrichment in the vicinity of Barrie has occurred. This fact is supported by higher phosphorus concentrations in the west end of the bay and production of the alga Cladophora in the same vicinity.

While phytoplankton production (as reflected by chlorophyll analyses) is quite low throughout the bay, comparative evaluations of dissolved oxygen levels at various depths and analyses of bottom fauna communities suggest an increase in the quantity of phytoplankton and possibly other organic solids settling to the bottom in recent years. This has caused oxygen depletion in the deeper waters and a corresponding shift in benthic communities from a dominance of midge larvae to more pollution-tolerant sludgeworms. The implications of these changes on the fishery resources of the lake is a point of major concern.

Elimination of existing artificial nutrient sources and provision of adequate nutrient containment associated with all future development will be necessary to minimize further effects resulting from aquatic enrichment.

This study has suggested the need for a more comprehensive evaluation of the impact of all existing

municipal and industrial development, cottage development and agricultural practices on the water quality of Lake Simcoe. This has been scheduled for the summer of 1971.

Clean water in Lake Simcoe is of paramount importance when we consider its size, it diverse recreational potential, including excellent fishing, and its proximity to the most densely-populated area of Ontario.

RECOMMENDATION

Every precaution should be taken to ensure that all future municipal, industrial and cottage subdivision developments along Lake Simcoe will incorporate adequate safeguards to prevent any increase in nutrient concentrations throughout the lake.

INTRODUCTION

During the past several years the OWRC has received numerous expressions of concern about pollution in Lake Simcoe. Most frequently, queries have been advanced about the potential pollution of Kempenfelt Bay, although complaints about increasing aquatic weed growths in Shingle Bay (near Orillia) and Cook Bay (south end of Lake Simcoe) have been received as well. On reviewing the situation, the OWRC has recognized the lack of information to clarify the state of the existing water quality of the lake was recognized. While the fishery has been investigated in considerable detail by MacCrimmon and Scobe (5), a complete study of water quality has never been undertaken, even though Lake Simcoe has enormous recreational potential which demands clean water for optimum utilization and enjoyment. General observations suggest that the quality of Lake Simcoe is good. Owing to the importance attached to the potential impact of wastes from the City of Barrie on Kempenfelt Bay, preliminary survey efforts in 1970 were directed to an analysis of that situation. A more complete study of the entire lake is scheduled for 1971.

Lake Simcoe is a relatively deep lake (maximum depth 136 feet). Because the maximum depth is in Kempenfelt Bay, the authors were concerned about possible

problems in the bay associated with temperature stratification and the lack of vertical mixing during summer months. Kempenfelt Bay receives municipal and industrial wastes from Barrie (approximately 2.5 million gallons per day) and logical questions centered on the possibility of nutrient build-up, as well as the depletion of dissolved oxygen in the deeper waters. Three sampling locations were chosen for monitoring chemical, physical and biological characteristics. Two stations were located in the bay and one in Lake Simcoe proper as shown in Figure 1 below.

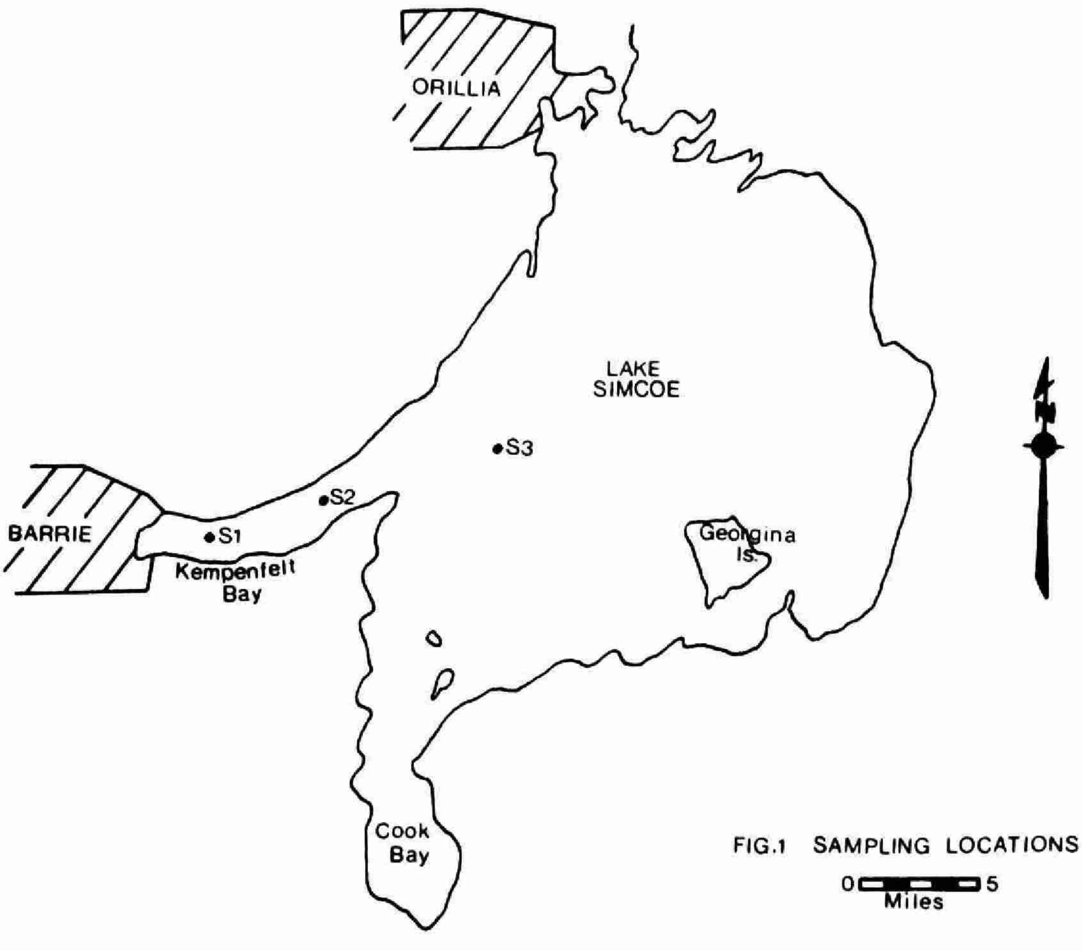


FIG.1 SAMPLING LOCATIONS •

PARAMETERS MEASURED

The 1970 work included chemical, physical and biological assessments. The sampling period extended from May to October.

Chemical analyses included measurements of phosphorus, nitrogen, carbon, silica, iron, dissolved oxygen, pH, conductivity and alkalinity. Physical analyses included measurements of transparency (secchi disc) and temperature. Biological evaluations were based on a study of bottom fauna communities and an index of phytoplankton production in the form of chlorophyll analyses.

METHODS

Chemical - Samples for chemical analyses were collected from three depths at each of the three sampling locations (S1, S2, S3) once per month during the sampling period. The sampling depths corresponded to 1) mid-way between the surface and thermocline, 2) in the thermocline, and 3) mid-way between the thermocline and bottom. On the September 29 sampling run, however, samples for analyses of dissolved oxygen, CO_2 and pH were collected at seven vertical depths at each sampling station.

Samples for analyses of phosphorus, nitrogen and dissolved oxygen were collected on each sampling run (6 runs). Samples for other chemical parameters were collected less frequently. All analyses were carried out according to standard procedures (Standard Methods. APHA, 1965).

Physical - Vertical temperature profiles were made using a telethermometer with a 150-foot extension probe. Water transparency was determined by means of a secchi disc (8-inches in diameter).

Biological - Samples for chlorophyll analyses were collected on each sampling run. Samples were taken from six depths at each station - five depths in the zone of algal production and one between bottom and the lowest depth to which algal production occurs (1% incident light). The samples were preserved by adding magnesium carbonate immediately after collection.

Bottom fauna samples were collected using a 9" x 9" Eckman dredge. One dredge per station per sampling run was collected, except for the first run (May 7) when a total of 10 dredge samples were collected at station S1 to test variability. The invertebrates were separated from the sediment using a brass screen (24 meshes per inch, 0.65 mm aperture) and were preserved in ethanol for subsequent analysis.

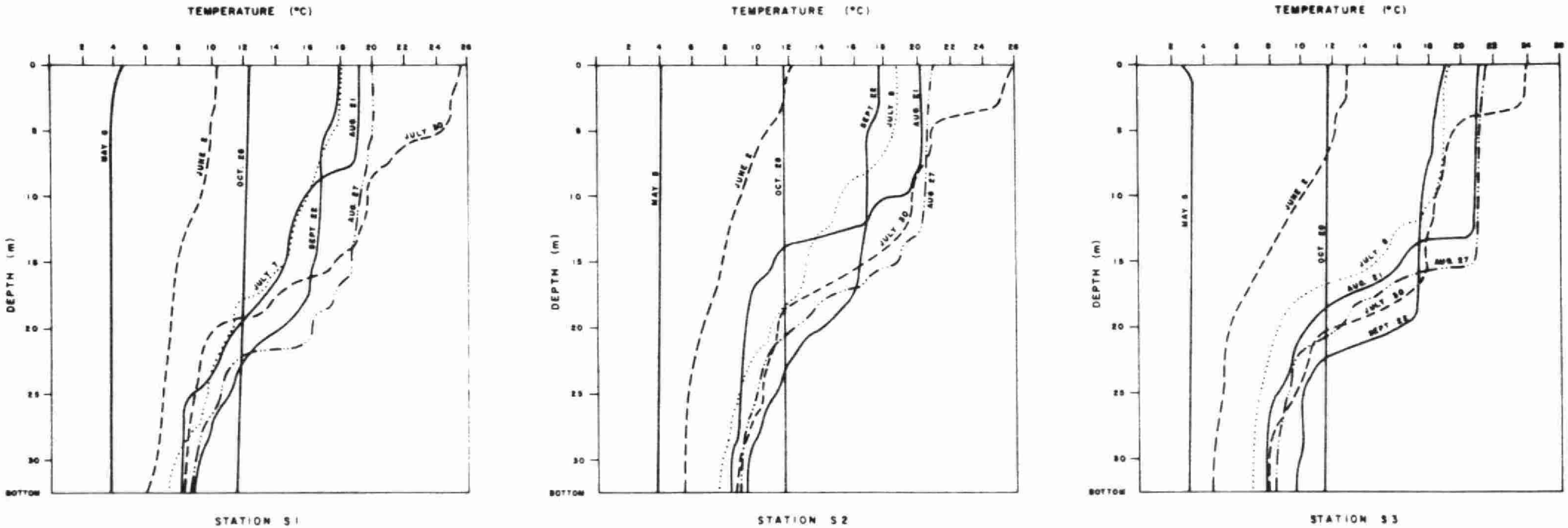
RESULTS

Physical

Figure 2 illustrates temperature profiles on the eight sampling dates. Temperature data indicate that thermal stratification was much more pronounced and stable at station S3 in Lake Simcoe than in Kempenfelt Bay (stations S1 and S2). The reason for this may possibly

FIGURE : 2

VERTICAL TEMPERATURE PROFILES AT THE THREE SAMPLING LOCATIONS



have been the increased turbulence resulting from rough-water conditions in the relatively isolated bay. During the sampling period Kempenfelt Bay was almost as rough as Lake Simcoe because of the prevailing wind moving along the bay's east-west axis.

There seems to be considerable variability in the time at which Lake Simcoe turns over. Temperature information from this study indicated that fall turnover took place in the early part of October. Rawson (1930) stated that stratification was destroyed as early as August 30. The time of lake turnover no doubt varies considerably with variations in meteorological conditions during late summer and fall.

Figure 3 illustrates the secchi disc values found on the six sampling dates. The values varied from about three meters to about six meters and were quite similar at the three sampling stations. The only major discrepancy between stations was noted on May 7 at which time the transparency increased from station S1 to station S2 to station S3.

The limit to which algal production is expected to occur is the one per cent incident light depth, estimated to be 2.5 times the secchi disc value. The depth of this zone ranged from 8 meters on July 7 at station S1 to 15 meters on May 7 at station S3.

Chemical

Figure 4 illustrates the dissolved oxygen concentrations found on the seven sampling dates and

FIGURE : 3
SECCHI DISC READINGS ON THE
SIX SAMPLING DATES

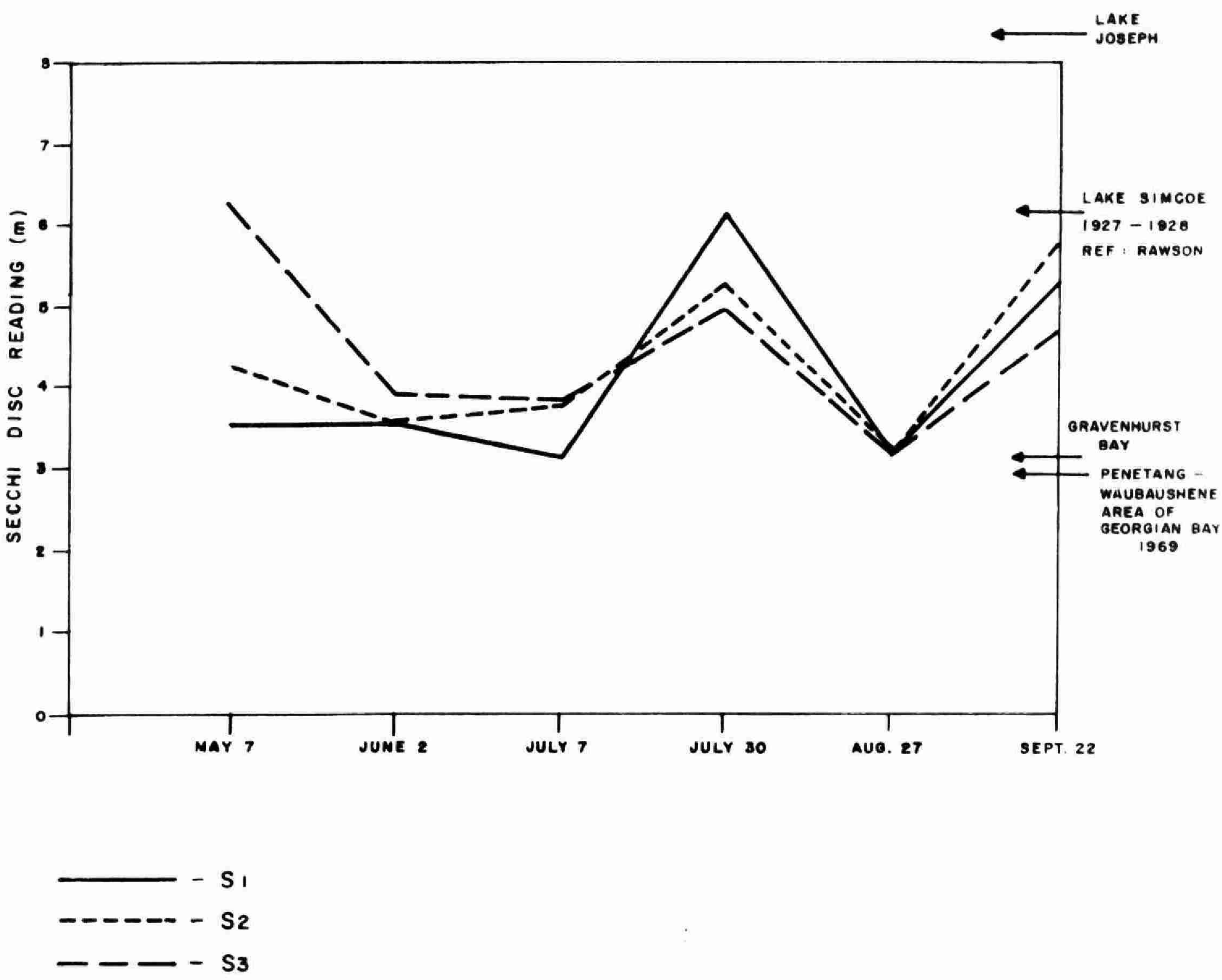


FIGURE 4

DISSOLVED OXYGEN CONCENTRATIONS AT THE THREE SAMPLING LOCATIONS

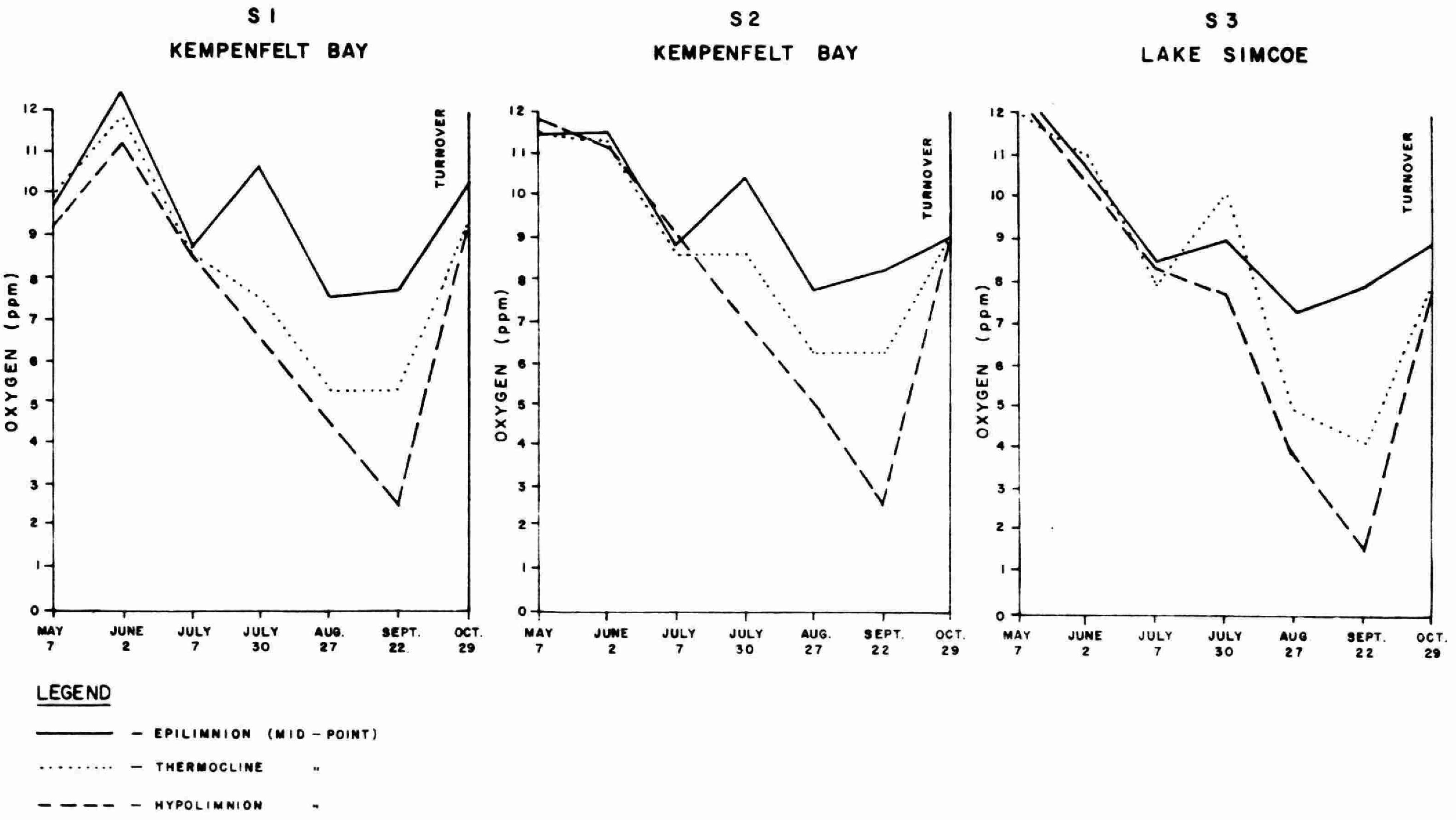


Figure 5 illustrates the profiles of dissolved oxygen, CO_2 and temperature found on September 29, when oxygen values had reached their minimum in the hypolimnion.

Dissolved oxygen concentrations in the bottom waters of the lake showed a steady decrease as the summer advanced. Just before the lake turned over, concentrations at two meters above the mud had reached a minimum of 2.4 ppm at S1, 1.4 at S2 and 1.0 at S3. At this time, concentrations at all depths in the hypolimnion were 3 ppm or less at the three sampling stations.

Carbon dioxide values were measured only on one sampling run (September 29) and ranged from 3 ppm to 13 ppm. CO_2 concentrations were considerably higher in the hypolimnion (see Figure 5) as a result of algal decomposition.

Figure 6 illustrates the concentrations of phosphorus at the three sampling locations. It is interesting to note that on the May 7 sampling run, there was a pronounced difference in phosphorus concentrations between the three sampling locations, with the phosphorus concentration at station S1 being quite high (0.04 ppm). The summer mean, however, (Figure 6) revealed that the stations were quite similar in phosphorus content during the summer months. It appeared that there was a build-up of phosphorus at the head of Kempenfelt Bay during ice cover which subsequently dispersed or was assimilated by the algae and carried to the bottom sediments. Other parameters measured (e.g. secchi disc, N, SiO_2) showed a

FIGURE : 5
VERTICAL PROFILES OF TEMPERATURE, DISSOLVED OXYGEN, AND CARBON DIOXIDE FOUND ON SEPT. 29, 1970 (JUST PRIOR TO FALL TURNOVER)

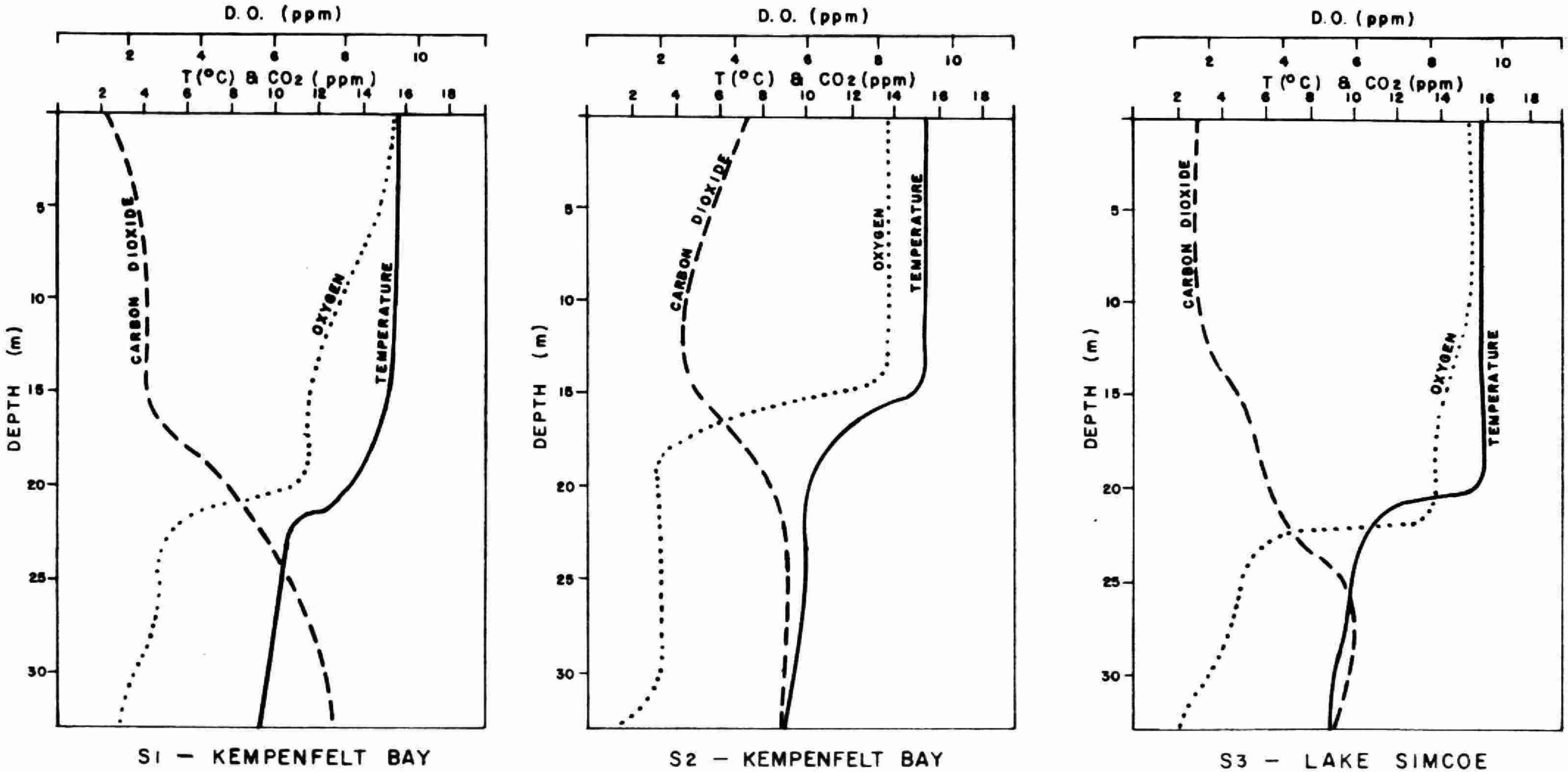
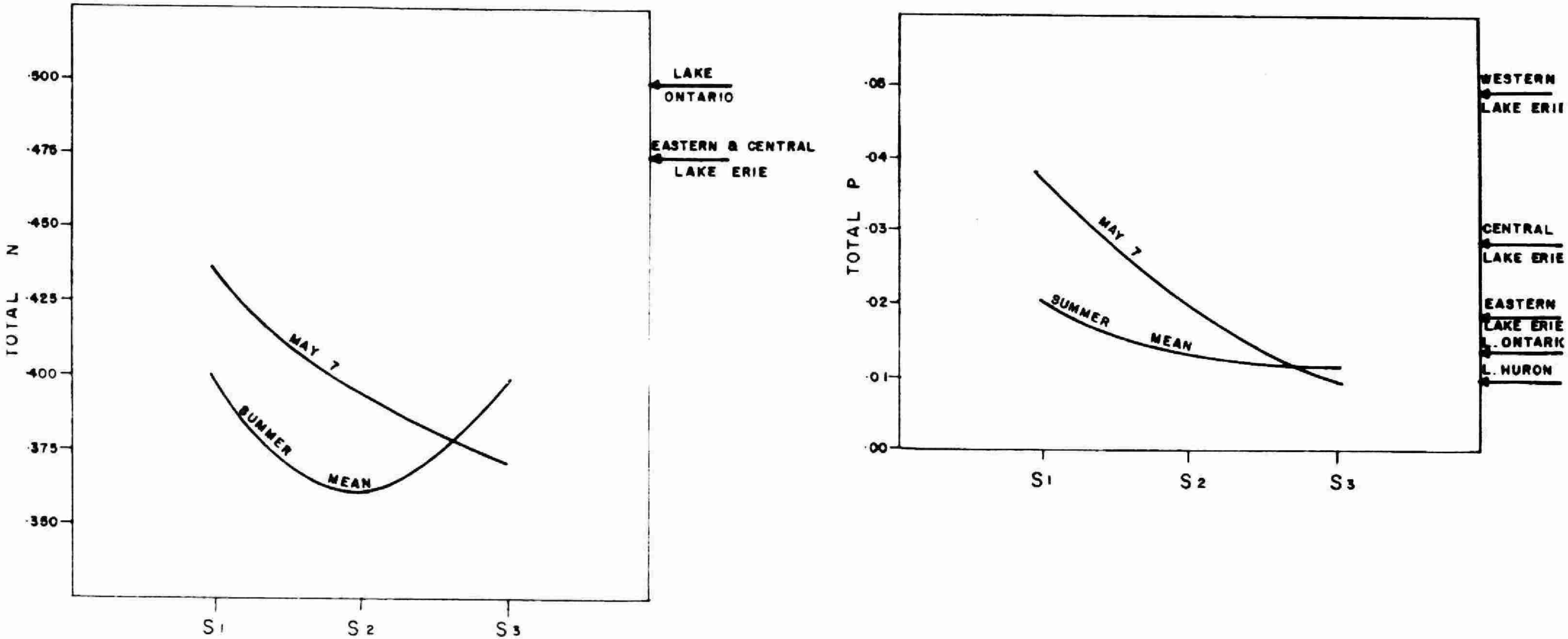


FIGURE : 6

CONCENTRATIONS OF PHOSPHORUS AND NITROGEN AT
THE THREE SAMPLING LOCATIONS
COMPARATIVE VALUES TAKEN FROM THE REPORT TO
THE INTERNATIONAL JOINT COMMISSION ON THE POLLUTION OF LAKE ERIE,
LAKE ONTARIO AND THE INTERNATIONAL SECTION OF THE ST. LAWRENCE RIVER



similar pattern of major differences between sampling points in early May, followed by quite uniform conditions during the summer months.

Total nitrogen values are also illustrated in Figure 6. The low summer average value at S2 is unexplainable.

Carbon analyses were conducted only on the August 21 and September 22 sampling runs. Total carbon was practically the same at the three sampling stations; station means varied from 33.2 ppm to 33.9 ppm. Unfortunately, carbon was not measured in the early part of the summer months.

Concentrations of silica ranged from 2.1 ppm at S1, May 7, to 0.19 ppm at S3, July 31. Iron values ranged from 0.05 ppm to 0.15 ppm.

Conductivity measurements ranged from 250 u mhos/ cm^2 to 325 u mhos/cm^2. The average conductivity for the three sampling stations is 290.

pH measurements ranged from 6.5 to 8.4 and varied little from station to station, or with depth. An average pH value for Lake Simcoe is about 7.5. Rawson (1930) reported the pH as 8.1.

Biological

Cladophora is a filamentous, macroscopic, green alga which attaches to rocks, posts and other firm

substrates in near-shore waters. Cladophora growths are usually a good indicator of nutrient enrichment because the alga becomes very abundant in nutrient-rich waters. During this study, growths of Cladophora were investigated in Kempenfelt Bay on August 28. The alga was found to be quite abundant at the west end of the bay and dwindled towards the main body of the lake. Along the north shore, Cladophora growths were scarce and practically non-existent along the eastern two-thirds of the bay. On the south shore, however, the alga was more widespread and only the eastern one-third of the shoreline was essentially free of this plant.

It appears that growths of Cladophora in Kempenfelt Bay are not yet extensive enough to cause problems as a result of the algal filaments breaking off and washing up on shore. No shoreline accumulations were noted during this study, unlike the Shingle Bay area (near Orillia) where shoreline accumulations of Cladophora have recently become a major problem.

Chlorophyll values were very low. Concentrations of chlorophyll ranged from 0.4 ppb to 2.4 ppb. Most samples contained values of about 1 ppb. Chlorophyll values were quite uniform throughout the water column which attested to the extent of vertical mixing.

Beds of rooted aquatic plants were common in the western part of Kempenfelt Bay. Large, dense beds were

restricted to the western shoreline and the western one-third of the southern shoreline. The plants were found only where a suitable mud bottom was present. Rooted aquatics obviously present only minor problems to residents of the Barrie area. One of the most significant problem areas noted was in the vicinity of the boat dock owned by the City of Barrie where dense growths impaired the aesthetic quality of the harbour and sometimes interfered with boat passage. Canada waterweed (*Anacharis canadensis*) and coontail (*Ceratophyllum* sp.) were two of the most common types of aquatic plants noted.

All three sampling stations had very similar bottom-dwelling animals. Table 1 illustrates the average numbers of organisms found at each station and Table 2 illustrates various analyses of community structure. The similarities between stations is indicated by uniform diversity indices and coefficients of similarity above 50% (Table 2); similar water quality conditions are indicated at the three sampling locations.

The benthic population at all three stations was dominated by sludgeworms which constituted from 85% to 93% of the total numbers of organisms. The two most common benthic species were *Tubifex tubifex* and *Limnodrilus hoffmeisteri*; both species are quite pollution-tolerant. At station S1, the two species were equally abundant (Table 1); at stations S2 and S3, *Tubifex tubifex* was considerably more abundant. The two other species of sludgeworms found were *Ilyodrilus templetoni* and *Potamothrix bedoti*.

Table 1. Average numbers of organisms (per M^2) found at the three sampling locations.

	S1	S2	S3
SLUDGE WORMS			
Tubifex tubifex	910	1000	1900
Limnodrilus hoffmeisteri	910	380	400
Ilyodrilus templetoni	31	47	30
Potamothrix bedoti	25	0	72
MOSQUITOES			
Chaoborus	130	72	30
MIDGES			
Procladius	19	13	34
Chironomus (s.g. Chironomus)	27	120	0
Chironomus (s.g. Tribelos)	0	0	10
Paratendipes	0	6	0
Polypedilum	0	3	0
(Tanytarsini)	1	3	48
(Orthocladiinae)	1	0	0
CLAMS			
Pisidium	23	34	70
AMPHIPODS			
Hyalella azteca	1	0	3
BEETLES			
(Haliplidae)	0	3	0
TOTAL	2076	1681	2587

Table 2. Some comparisons between benthic communities at the three sampling locations.

Sampling Stations	Margalef's Diversity Index (1)		Coefficient of Community Similarity (2) S1	S2	S3	# Organisms per M^2	% Sludge Worms	% Limnodrilus hoffmeisteri
S1	1.3	S1		57	75	2076	91	44
S2	1.3	S2	57		50	1681	85	23
S3	1.1	S3	75	50		2597	93	15

1. Margalef's Diversity Index

$$D^1 = \frac{S-1}{\log_e N}$$

where S= # of taxa
N= # of organisms

2. Coefficient of Community Similarity

$$C = \frac{c}{a+b-c} \times 100$$

where a = # species in 1st sample location
b = " " " 2nd "
c = # species common to both sample locations

Midges constituted the second most abundant group of organisms, making up less than 10% of the population. The only two commonly found genera were *Procladius* and *Chironomus* (sub genus *Chironomus*). Other groups included mosquitoes (*Chaoborus*), clams (*Pisidium*), amphipods (*Hyalella azteca*) and beetles (*Haliplidae*).

DISCUSSION

Lake Simcoe is a deep, cold-water lake which is subject to high wave action and extensive vertical mixing. Temperature stratification begins in May and the lake remains stratified until fall turnover (September or October). Unlike many other inland lakes, Lake Simcoe seldom has a single, pronounced thermocline; usually there is a gradual decrease in temperature from top to bottom with one or more weak thermoclines. Thermal stratification appears to be less pronounced in Kempenfelt Bay than in Lake Simcoe proper. The reason for this probably lies in the fact that Kempenfelt Bay experiences heavy wave action because the length of it lies parallel to the direction of the prevailing westerly winds.

The present study indicated that while the water quality of Kempenfelt Bay and adjacent Lake Simcoe is basically good, there is evidence of an enrichment problem in the Barrie area. Phosphorus, which has recently been identified as the major nutrient causing excessive algae

growths on the Lower Great Lakes (4), is considerably more concentrated in the Barrie area (0.022 ppm summer mean at station S1) than in Lake Simcoe proper (0.015 ppm summer mean at station S3). Previous work by the authors (unpublished) has indicated that when a phosphorus concentration of 0.020 is reached, fall blooms of blue-green algae can be expected even though the concentration of planktonic algae through the summer may be quite low. To the authors knowledge, a fall bloom did not materialize in 1970, possibly because of unfavourable meteorological conditions. However, while the values for phytoplankton concentrations (chlorophyll a) indicate that phytoplankton productivity is very low, fall blooms of blue-green algae can be expected in the Barrie area because of the existing phosphorus levels. Shoreline accumulations of blue-green algae in Kempenfelt Bay were noted by a representative of the Biology Branch of the OWRC in September of 1969.

Comparisons between the values of phosphorus, nitrogen and carbon in the study area with those found in the Muskoka Lakes (unpublished) support the fact that phosphorus appears to be the key nutrient in regulating algal production. Gravenhurst Bay, which supports the development of major algae blooms each fall and has five times the concentration of chlorophyll a during the summer, has approximately four times as much total phosphorus concentration as Lake Simcoe. It has approximately twice the total nitrogen concentration and approximately one-third the total carbon concentration found in Lake Simcoe.

It is evident from this that for each unit of phosphorus in the two areas, Lake Simcoe has a much greater supply of nitrogen and carbon than does Gravenhurst Bay.

LAKE SIMCOE

Station	Total P	Total N ppm	Total C	P/N/C	Chlorophyll *a* (ppb)
S1	0.022	0.391	33.4	1/17/1500	1
S2	0.016	0.354	33.1	1/23/2100	1
S3	0.015	0.375	33.5	1/28/2400	1

MUSKOKA LAKES

Station	Total P	Total N ppm	Total C	P/N/C	Chlorophyll *a* (ppb)
Gravenhurst Bay	0.060	0.635	9.3	1/11/155	5

A recent study of the Muskoka Lakes demonstrated that phosphorus is the most important nutrient in regulating algal production in Gravenhurst Bay (Michalski - private comm.) and it can therefore be assumed that phosphorus is probably even more limiting in Lake Simcoe.

There appears to be a pronounced build-up of nutrients (N and P) in the Barrie area during the winter

months which is subsequently dispersed, or is assimilated by the algae and carried to the bottom sediments. Figures 3 and 6 illustrate the fact that major differences existed, in terms of water transparency and concentrations of nitrogen and phosphorus, between the three sampling locations on the first sampling run (shortly after ice break-up). Later in the summer, one chemical parameter (i.e. P) showed minor differences between stations, while the other parameters indicated fairly uniform water quality characteristics. It therefore appears that winter sampling is necessary to determine the extent of nutrient build-up in the Barrie area during ice cover.

Regarding recent changes in the water quality of Lake Simcoe, interesting comparisons can be made between data from the present study and those reported by Rawson (7) in 1930. For example, Rawson reported an average secchi disc value of six meters (6 measurements); data from the present study gave an average value of 4.3 meters (6 measurements) in the lake proper (station S3).

Comparisons between the bottom faunal community found in 1970 and that found by Rawson in 1927-28 also indicate that major changes have taken place in the past forty years. Rawson found that midge fly larvae constituted the majority (76%) of invertebrates in deep water and sludgeworms rated second (9%) in abundance. The present survey revealed that sludgeworms now dominate (90%) the deep-water community and midges constitute only 5%. Decreased dissolved oxygen concentrations in the hypolimnion

related to increased decomposition of settled algae and possibly other organic solids are the likely cause of this major change in the benthos.

The present study indicated that concentrations of dissolved oxygen in the hypolimnion provide cause for definite concern. There is a steady decrease in dissolved oxygen concentrations as the summer progresses (Figure 4). By late September of 1970, the hypolimnion at the three sampling stations contained 3 ppm or less of dissolved oxygen and a minimum value of 1 ppm was measured in Lake Simcoe proper (station S3) one meter above the bottom. Just before fall turnover (September 29 sampling run), the top of the hypolimnion was at a depth of approximately 22 meters. Assuming that the vertical profiles of dissolved oxygen and temperature measured at station S3 were representative of the lake, the hypolimnion, with a maximum dissolved oxygen concentration of 3 ppm, would occupy 25 per cent of the lake in late summer.

Unfortunately, comparisons of dissolved oxygen with Rawson's work are questionable. Rawson reported a minimum dissolved oxygen concentration in the summer (July 15, 1927 or 28) in the hypolimnion near Georgina Island of 2.9 ppm. However, he reports values in surface water for May, June and July of 5.6, 6.4 and 5.6 ppm respectively. These correspond to saturation values of 42%, 62% and 59%, respectively, which appear to be too low. These data invite the question whether his report

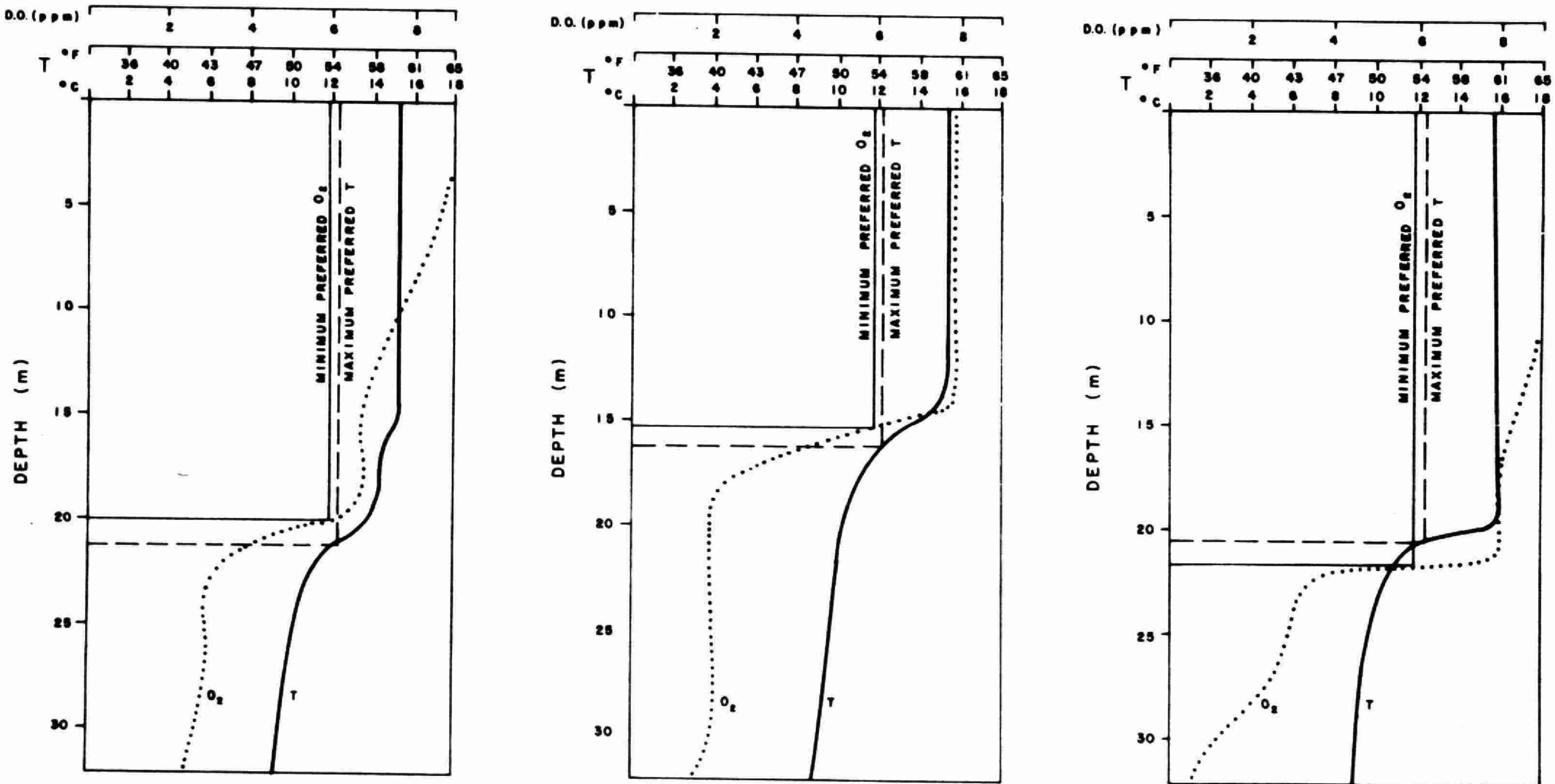
of 2.9 ppm is also too low. MacCrimmon and Scobe (5) state that "the water of Lake Simcoe is very clear and generally well oxygenated at all depths at all seasons of the year." This statement is a result of dissolved oxygen measurements which have been taken by the Ontario Department of Lands and Forests in connection with their studies on lake trout spawning beds. However, most of the measurements were done in epilimnetic water which naturally remains near saturation. Therefore, while meaningful historical comparisons on dissolved oxygen are difficult to make, indications are that low values of dissolved oxygen in the hypolimnion may well be a recent development.

The possible effects of low dissolved oxygen values on fish should certainly be further evaluated. Salmonid fishes in general migrate to deeper waters during the summer and inhabit depths which contain preferred temperature levels. Lake trout, for example, normally prefer water temperatures between 45 and 55° F (3) and the majority of trout would inhabit depths corresponding to this temperature range. However, as is illustrated in Figure 7, the depths corresponding to these temperatures on September 29 contained basically 3 ppm oxygen which is certainly too low for suitable physiological responses in lake trout. It is likely that during late summer stratification, lake trout (and perhaps whitefish) are placed under stress in their efforts to avoid both low oxygen and high temperatures. The dissolved oxygen requirements for lake trout are not well documented but

FIGURE · 7

AN ILLUSTRATION OF TEMPERATURE AND OXYGEN STRESS ON LAKE TROUT DURING LATE SUMMER STRATIFICATION

(DATA FROM SEPTEMBER 29, 1970)



S1 — KEMPENFELT BAY

PREFERRED SWIMMING DEPTH WITH RESPECT TO BOTH T & O_2 NOT AVAILABLE

S2 — KEMPENFELT BAY

PREFERRED SWIMMING DEPTH WITH RESPECT TO BOTH T & O_2 NOT AVAILABLE

S3 — LAKE SIMCOE

PREFERRED SWIMMING DEPTH WITH RESPECT TO BOTH T & O_2 RESTRICTED TO A ONE METER LAYER IN THE THERMOCLINE

it is generally understood that trout should have at least 6 ppm dissolved oxygen for normal growth and physiological responses. As is illustrated in Figure 7, on September 29, a preferred vertical zone (preferred with respect to both dissolved oxygen and temperature) for lake trout did not exist in Kempenfelt Bay. In Lake Simcoe proper (station S3), the preferred zone was restricted to about a one-meter layer in the thermocline. It therefore appears that lake trout (and perhaps other salmonids) may be placed under stress just prior to lake turnover. Whether or not this stress is of sufficient magnitude or length to have a pronounced effect on the salmonids is not known, but this preliminary information warrants further consideration. Certainly, these preliminary data suggest the need to limit further oxygen reduction. Owing to the relationship between phytoplankton productivity and oxygen consumption in the hypolimnion, efforts should be made now to prevent any further increase in primary productivity.

Another potential lake-wide problem is that caused by Cladophora growths. Growths of this alga are especially prominent in the Barrie area. In the Orillia area (Shingle Bay), Cladophora growths are even more luxurious and aesthetic problems have recently developed as a result of the alga washing up on shore during stormy periods. While the present study revealed that Cladophora growths are practically non-existent in the outer part of Kempenfelt Bay and adjacent Lake Simcoe, reports from

fishermen indicate that the alga may be growing in sections of the outer lake. In general, the extent of *Cladophora* growth is in proportion to the supply of nutrients; studies by Neil and Owen (6) demonstrated that this alga readily responds to additions of phosphorus in Lake Huron. Recent information by Fitzgerald (2) indicated that phosphorus values as low as 0.02 ppm can promote growths of *Cladophora*. It appears that the phosphorus-rich wastes from Barrie have created this accumulation of phosphorus and the associated *Cladophora* problem at the head of Kempenfelt Bay.

The possibility of this alga covering and depreciating lake trout and whitefish spawning shoals should be fully investigated. Webster (8), referring to lake trout in Cayuga Lake, stated that 'the trout seek an area where the bottom is kept clean by strong sub-surface currents'. *Cladophora* growths would not only destroy spawning beds in a physical sense, but algal decomposition could prevent successful hatching of eggs by depleting the oxygen supply in the interstices where the eggs develop. MacCrimmon and Scobe (5) state that 'spawning occurs from the shore outward into water 12 feet or more in depth' and it is in the shallow waters where the maximum production of *Cladophora* occurs.

ACKNOWLEDGEMENTS

Two university students, Mr. Dennis Wright and Mr. Scott Millard, capably assisted with the collection of samples and completion of chemical analyses during the field program.

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GLOSSARY OF TERMS

Algae - primitive plants which form the basis of aquatic food chains. Most species of algae are very small (microscopic). Algae are present in all natural waters.

Algae Bloom - a short-term proliferation of algae cells. During a bloom, algae becomes so concentrated that it frequently covers the waters surface with a green scum.

Alkalinity - the ability of water to neutralize acids. Alkalinity comes from hydroxides as well as carbonates, bicarbonates, and other salts of weak acids.

Anaerobism - without oxygen.

Bottom fauna - animals living on the bottom of lakes and rivers.

Chlorophyll - the green plant pigment responsible for photosynthesis.

Cladophora - a green, filamentous, macroscopic alga.

Coefficient of similarity - an expression relating to the similarity of biological communities.

Conductivity - the ability of water to carry an electric current. Dissolved solids increase conductivity.

Diversity index - an index which refers to the variety of organisms within a biological community.

Eckman dredge - a device used to collect mud samples from a lake.

Epilimnion - the near-surface, warm waters of a lake.

Euphotic zone - the waters of a lake which receive sufficient light for photosynthetic activity.

Hypolimnion - the bottom, cold waters of a lake.

1% - incident light depth - the depth of penetration for 1% of the light that is present at the surface of the water.

pH - A measure of the concentration of free hydrogen ions in water.

Phytoplankton - free-floating microscopic algae cells which sometimes may be slightly motile.

Planktonic algae - see phytoplankton.

ppb - parts per billion.

ppm - parts per million.

Secchi disc - a disc with alternate quadrants painted black and white, used to measure water transparency.

Sludgeworm - an aquatic worm that is, in general, pollution-tolerant.

Telethermometer - a device used to measure water temperatures at any desired depth.

Thermocline - the layer of water separating the epilimnion from the hypolimnion. Thermoclines have marked temperature changes within short vertical distances.

Turnover - a phenomenon which occurs in spring and fall, bringing surface and bottom waters to similar temperatures and densities; denser water sinks and displaces warmer water below until the entire lake is of uniform temperature.

07/13/09